

SEISMIC ACTIVITY OF MOUNT EREBUS IN 1987

Katsutada KAMINUMA¹ and Katsumi MURAKAMI²

¹*National Institute of Polar Research, 9-10, Kaga 1-chome,
Itabashi-ku, Tokyo 173*

²*Faculty of Science, Tohoku University, 1117, Kita Kaname, Hiratsuka 259*

Abstract: In 1987, five seismic stations were operated in the summit area and on the flanks of Mount Erebus (77°37'S, 167°09'E, 3794 m) and one station at the summit of Mount Terror in Ross Island, Antarctica. Two stations (TRC and E1) in the summit area out of five were operated well throughout the year. Therefore the hypocenters of only 48 earthquakes were determined using the seismic phase readings at five stations in 1987. The earthquakes are localized around the summit region. The averaged daily count of earthquakes at TRC is 64. This is reduced to 16 for HOO which is located on the flank of Mount Erebus. The daily numbers before 1986 were counted at HOO. The seismic activity around Mount Erebus in 1987 was as low as that in 1985 and 1986, and the trend of the low seismic activity lasted after the 1984 volcanic activity.

1. Introduction

The seismic observation of Mount Erebus (77°37'S, 167°09'E, 3794 m) in Ross Island, Antarctica was started in December 1980 by IMESS (International Mount Erebus Seismic Study) of Japan, New Zealand and the United States of America and was continued until December 1986 (KIENLE *et al.*, 1981; TAKANAMI *et al.*, 1983a, b; KAMINUMA, 1987). The seismic network has now been taken over by IMEEMS (International Mount Erebus Eruption Mechanism Study) of Japan and New Zealand, but the number of seismic stations has been decreased to six from ten since January 1987 (KAMINUMA *et al.*, 1988). The goal of IMEEMS is to study the eruption mechanism and the seismic activity of Mount Erebus.

Two infrasonic sensors were installed at E1 and TRC in December 1986 (see Fig. 1). Both seismic and infrasonic signals are transmitted to Scott Base, 38 km south from the Erebus summit by radio-telemetry and are recorded on a 14-channel FM data recorder (DIBBLE *et al.*, 1984).

A TV camera was also installed on the rim of the main crater of Mount Erebus for observing eruptions from the lava lake which appeared since December 1985. The recording of eruptions by the TV camera, and the seismic and infrasonic observations were continued throughout the year of 1987 (DIBBLE *et al.*, 1988; KAMINUMA *et al.*, 1988).

The seismic activity of Mount Erebus in 1987 is studied in this paper.

2. Seismic Network and Background Seismicity

The seismic network of Mount Erebus in 1987 is shown in Fig. 1. Two stations (E1 and TRC) are located in the summit area of Mount Erebus, other three stations (HOO, ABB and BOM) are on the flanks and one station (TER) is on the summit of Mount Terror. The seismic signals are transmitted to Scott Base of New Zealand by radio-telemetry, and recorded on a 14-channel FM data recorder and a one-channel chart recorder for monitoring.

Before the 1984 volcanic activity, Strombolian type eruptions had occurred several times every day since December 1972, when the lava lake in the inner crater was first recognized (KYLE and OTWAY, 1982). The daily number of eruptions ranged from a few to over ten per day, according to the visual and acoustic observations by scientists staying in the summit area during the austral summer field season (mainly from late November to early January).

Even in the largest case, the pre-1984 eruptions were small. Ejecta was blown away by at most several hundred meters, just outside of the crater rim.

On 13 September 1984, a new phase of volcanic activity occurred. More than twenty eruptions occurred every day in the first ten days from September 13 (KAMINUMA *et al.*, 1987). Volcanic bombs and ash were blown out more than one kilometer from the lava lake and covered the central cone of Mount Erebus, changing the white snow surface to gray. This explosive activity lasted till the end of the year.

The seismic activity before the 1984 volcanic activity was characterized by 50–100 earthquakes per day, as counted at HOO, and several earthquake swarms occurred each year. Earthquakes were located not only in the Erebus mountain area but also throughout Ross Island. However, during 1985 and 1986 after the 1984 volcanic activity, the daily earthquake counts at HOO decreased to less than 20, only one or

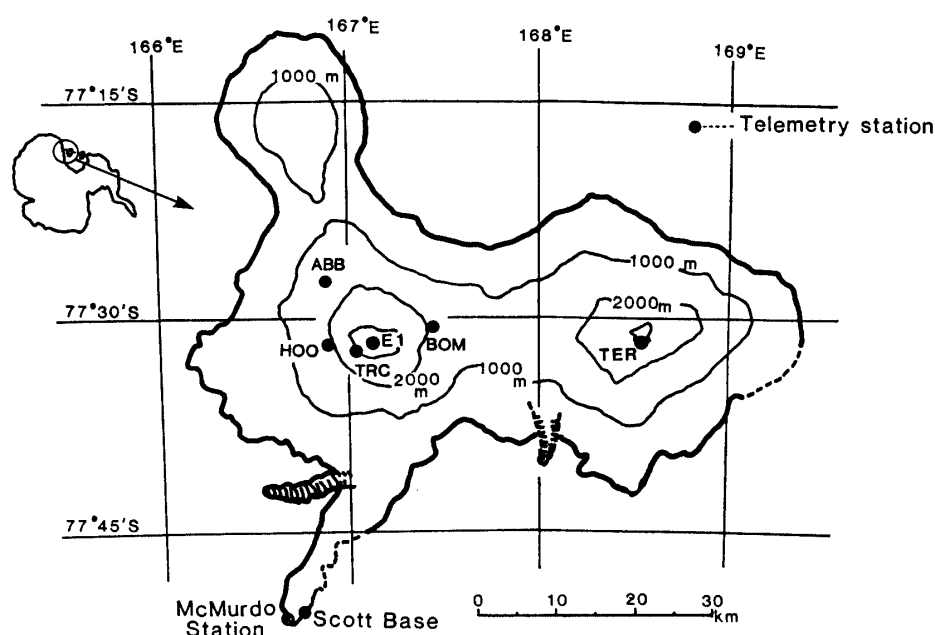


Fig. 1. The IMEEMS seismic network of Mount Erebus operated in 1987.

two earthquake swarms were recorded, and earthquake locations were clustered in the summit area of Mount Erebus (KAMINUMA, 1987).

3. The 1987 Activity

The daily number of earthquakes counted at TRC, 2.3 km southwest from the lava lake in the inner crater, is shown in Fig. 2. The daily numbers in our previous papers of the Erebus seismic studies were counted at HOO (*e.g.*, KAMINUMA *et al.*, 1986, 1987; KAMINUMA, 1987). The daily counts at HOO in 1984, 1985 and 1986 are shown in Fig. 3. However, the recordings at HOO was discontinued by electric power trouble in 1987. We played back the seismograms of both HOO and TRC for one week and counted the daily numbers at the two stations, and concluded that daily numbers at TRC are about four times larger than those at HOO. Therefore, for easy comparison of the daily numbers in Fig. 2 with those in Fig. 3 and in the other previous papers (*e.g.*, KAMINUMA *et al.*, 1985, 1986), a reduced scale is given for HOO in the right side axis of Fig. 2.

The average daily counts at TRC in 1987 are 64, then the reduced counts at HOO become 16. This value is nearly the same as the daily counts of the previous two years (KAMINUMA, 1987). The daily counts decreased suddenly from the end of December 1984 after the 1984 new volcanic activity as shown in Fig. 3. The trend of low daily counts continued into 1987.

After the 1984 volcanic activity, the number of earthquake swarms per year has also been very low. During 1987, only one event like an earthquake swarm was recognized in early May in Fig. 2.

The event started at 1200 (UT) on May 1 and lasted for 84 hours. The maximum daily counts are 739, the total number of earthquakes is 1886 and the average number of earthquakes per hour is 22.5. However, as already described, the daily counts at TRC are about four times larger than those at HOO. The reduced maximum daily counts at HOO are 185, the reduced total number of earthquakes are 472, and the reduced average number of earthquakes per hour is 5.6. The event is not an earthquake swarm, according to the definition of the earthquake swarm by KAMINUMA *et al.* (1985). Figure 4 shows the duration, the total number of earthquakes, and the average number per hour for each earthquake swarm during 1982–1986. The event in 1987 counted at TRC is also shown in the figure with the reduced

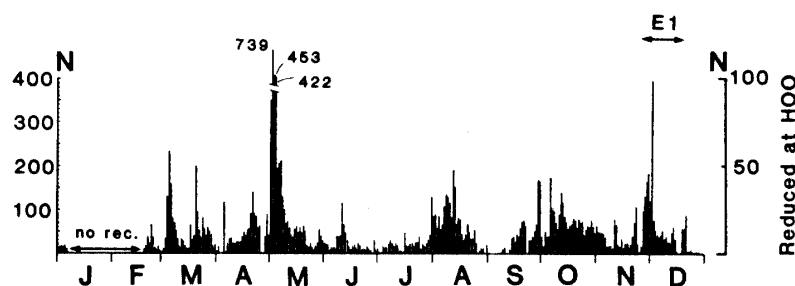


Fig. 2. Daily number of earthquakes in and around Mount Erebus counted at Truncated Cone Station (TRC) in 1987.

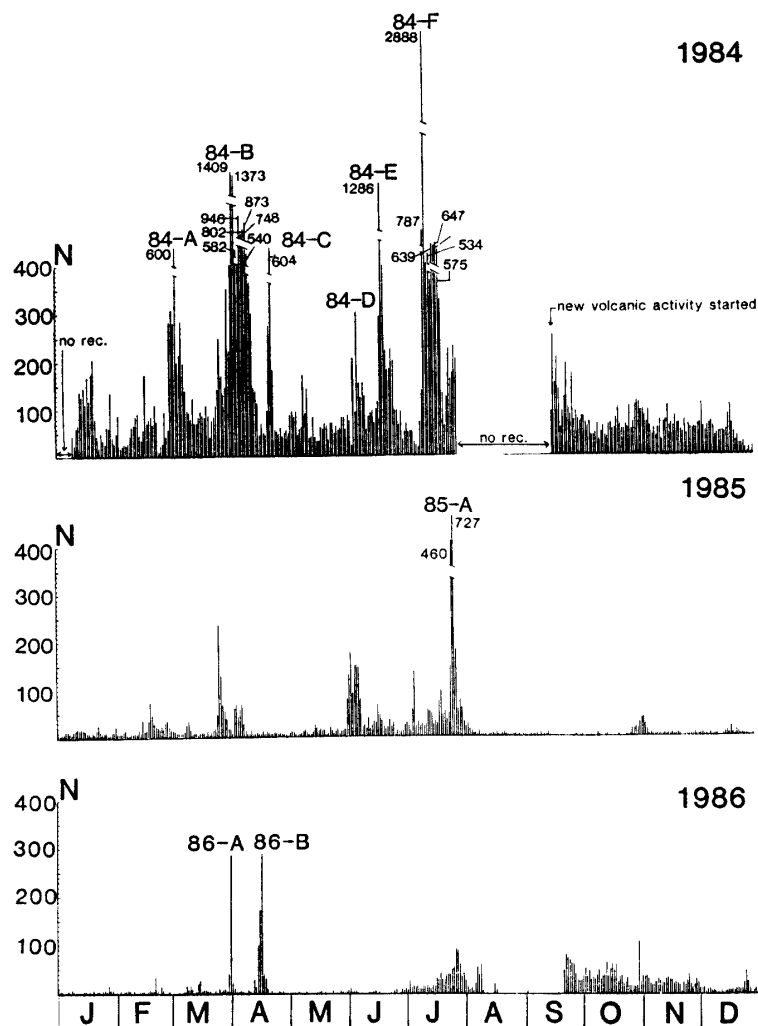


Fig. 3. Daily number of earthquakes in and around Mount Erebus counted at Hoopers Shoulder Station (HOO) in 1984, 1985 and 1986.

numbers. It is clear from the figure that the event is a very small activity.

The locations of 48 earthquakes have been determined during January 1–7 and November 27–December 20 in 1987, because only two stations, TRC and E1, were operated well throughout the year. As shown by hypocenter distributions (Fig. 5), earthquakes are clustered around the summit in the area within 5 km in horizontal and less than 4 km in vertical distances from the summit, nearly the same as the hypocenter distributions as in the previous two years. However, the earthquakes in 1982–1984, before the 1984 activity, were located throughout the Erebus Mountain area and Ross Island (KAMINUMA, 1987).

After the 1984 volcanic activity, the trend of earthquake locations has become more localized around the summit region. The seismic activity around Mount Erebus in 1987 was as low as that in the previous two years.

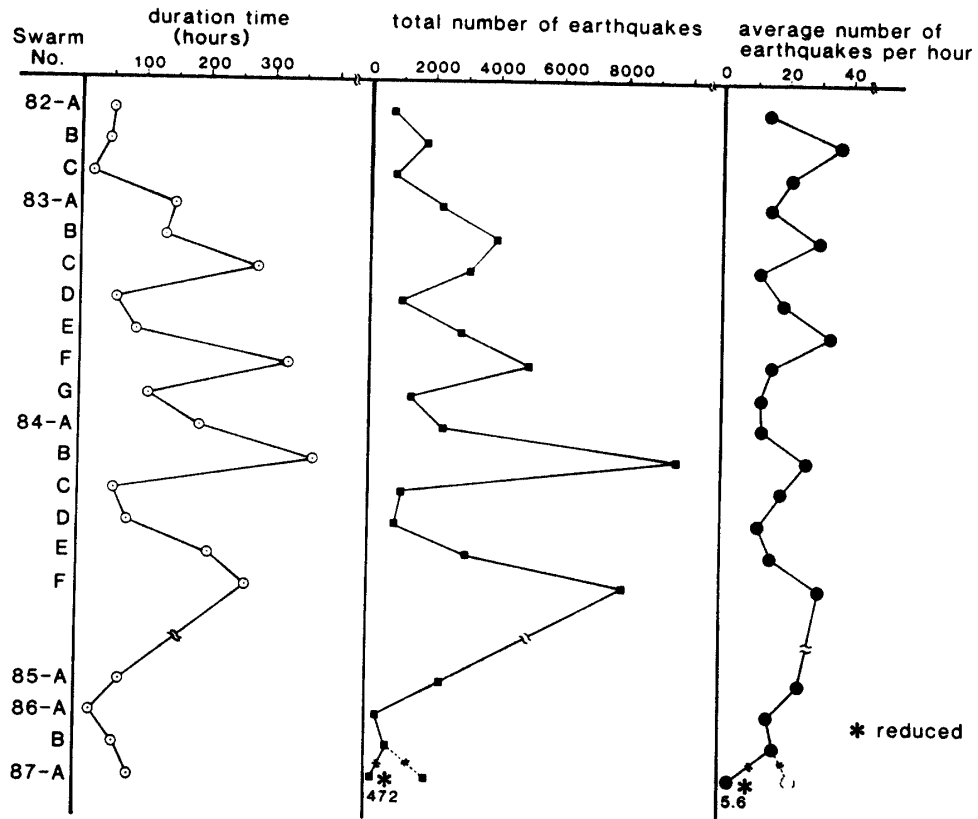


Fig. 4. Duration time, the total number of earthquakes and the average number of earthquakes per hour of earthquake swarms which occurred in Mount Erebus during 1982-1987.

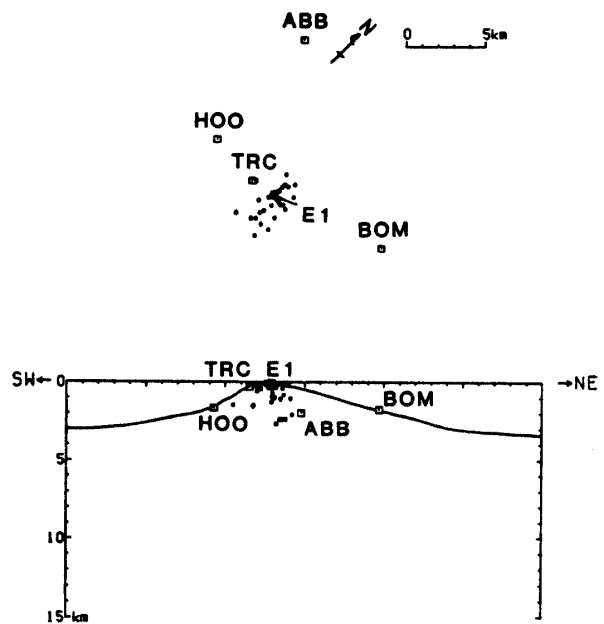


Fig. 5. Hypocenter location of earthquakes.

4. Conclusion

The seismic activity of Mount Erebus in 1987 is summarized as follows:

1) The average daily number of earthquakes counted at TRC is 64. The daily numbers at TRC are about four times larger than those at HOO, of which daily counts were reported in the previous papers (*e.g.*, KAMINUMA, 1987). The reduced daily counts at HOO become 16 (see Fig. 2).

2) The hypocenter distributions are clustered around the summit in the area within 5 km in horizontal and less than 4 km in vertical distances from the summit (see Fig. 5).

3) Only one event like an earthquake swarm is recorded during 1987. However, this is not an earthquake swarm according to the definition of the earthquake swarm by KAMINUMA *et al.* (1985) (see Fig. 4).

The seismic activity around Mount Erebus in 1987 was as low as that in the previous two years. The trend of the low seismic activity lasted after the 1984 volcanic activity.

Acknowledgments

The authors express their sincere thanks to Dr. R. R. DIBBLE, Victoria University of Wellington and to the laboratory technicians of the Scott Base wintering party for their kind international cooperation. The authors thanks are extended to Ms. Y. SHUDO and Ms. A. TAKAHASHI for their help throughout this study.

References

- DIBBLE, R. R., KIENLE, J., KYLE, P. R. and SHIBUYA, K. (1984): Geophysical studies of Erebus Volcano, Antarctica, from December 1974 to January 1982. *N. Z. J. Geol. Geophys.*, **27**, 425–455.
- DIBBLE, R. R., BARRETT, S. I. D., KAMINUMA, K., MIURA, S., KIENLE, J., ROWE, C. A., KYLE, P. R. and McINTOSH, W. C. (1988): Time comparisons between video and seismic signals from explosions in the Lava Lake of Erebus Volcano, Antarctica. *Bull. Disas. Prev. Res. Inst., Kyoto Univ.*, **38**, Part 3, 49–63.
- GIGGENBACH, W. F., KYLE, P. R. and LYON, G. L. (1973): Present volcanic activity on Mount Erebus, Ross Island, Antarctica. *Geology*, **1**, 135–136.
- KAMINUMA, K. (1987): Seismic activity of Erebus Volcano, Antarctica. *Pure Appl. Geophys.*, **125**, 993–1008.
- KAMINUMA, K., UEKI, S. and KIENLE, J. (1985): Volcanic earthquake swarms at Mt. Erebus, Antarctica. *Tectonophysics*, **114**, 357–369.
- KAMINUMA, K., BABA, M. and UEKI, S. (1986): Earthquake swarms on Mount Erebus, Antarctica. *J. Geodyn.*, **6**, 391–404.
- KAMINUMA, K., AMINO, J. and MIURA, S. (1987): Seismic activity of Mount Erebus in 1984–1985. *Proc. NIPR Symp. Antarct. Geosci.*, **1**, 1–5.
- KAMINUMA, K., MIURA, S. and DIBBLE, R. R. (1988): A process of Mount Erebus eruption. *Proc. NIPR Symp. Antarct. Geosci.*, **2**, 7–16.
- KIENLE, J., KYLE, P. R., ESTES, S., TAKANAMI, T. and DIBBLE, R. R. (1981): Seismicity of Mount Erebus 1980–1981. *Antarct. J.U.S.*, **16**(5), 35–36.
- KYLE, P. R. and OTWAY, P. (1982): Volcanic activity of Mount Erebus, 1981–1982. *Antarct. J.U.S.*, **17**(5), 31–32.

- TAKANAMI, T., KAMINUMA, K., TERAJ, K. and OSADA, N. (1983a): Seismological observations on Mount Erebus, Ross Island, Antarctica, 1980-1981. Mem. Natl Inst. Polar Res., Spec. Issue, **28**, 46-53.
- TAKANAMI, T., KIENLE, J., DIBBLE, R. R., KAMINUMA, K. and SHIBUYA, K. (1983b): Seismological observation on Mount Erebus, 1980-1981. Antarctic Earth Science, ed. by R. L. OLIVER *et al.* Canberra, Aust. Acad. Sci., 671-674.

(Received March 11, 1989; Revised manuscript received May 9, 1989)